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FINAL

INTERIM MEASURE/INTERIM REMEDIAL ACTION FRENCH DRAIN PERFORMANCE MONITORING PLAN

Rocky Flats Plant
881 Hillside Area

(Operable Unit No. 1)

U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant
Golden, Colorado

ENVIRONMENTAL RESTORATION PROGRAM

8 June 1992

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EXECUTIVE SUMMARY

The Operable Unit No. 1 (OU1) Interim Measure/Interim Remedial Action (IM/IRA) involves construction of a french drain (trench) to intercept contaminated alluvial/colluvial groundwater from the 881 Hillside Area. The IM/IRA Plan specified construction of an additional 500-foot segment of drain further west of the present western terminus. The drain was shortened on the western end for the following reasons:

- Slope instability caused by further construction of the french drain would have posed significant health and safety risks for personnel working within the trench excavation.

- Further construction would jeopardize the stability of the hillside and place stresses on the gas transmission line in this area. Test pits dug at 100 feet intervals west of the present western terminus encountered saturated alluvium, including artesian conditions at one location. It was felt that continued construction would undermine the foundation of the hillside and promote conditions favorable to slumping.

- Further construction of the french drain through the saturated soils that were encountered would have been hindered due to the continuous slumping of soils into the excavation.

- Groundwater modeling showed that any contaminated groundwater originating from an Individual Hazardous Substance Site (IHSS) within OU1 would effectively be captured by the drain at its present western terminus. (The modelling documentation and flow nets are included in Appendix A). The monitoring plan presented in this document should confirm this determination.

- The additional 500-foot segment of the drain would capture clean groundwater, which would significantly dilute contaminated waters collected by the drain and result in less effective removal of contaminants by the treatment plant.

This monitoring plan was specifically requested by the Environmental Protection Agency (EPA) and the Colorado Department of Health (CDH) during a meeting with U.S. Department of Energy and EG&G personnel on 26 March 1992. The agencies required that a program be established to evaluate the effectiveness of the french drain, and preparation and implementation of the monitoring plan was a condition for approving the western terminus location. This monitoring plan addresses the concerns of the CDH and the EPA regarding the potential for

alluvial groundwater migration around the drain. It also presents plans to monitor alluvial groundwater flow, if any, beneath the drain in shear planes, fault zones, sandstones, and weathered claystone. Eleven new and two existing monitoring wells will be used to monitor the french drain effectiveness. Furthermore, the plan is designed to characterize flow and water quality of the South Interceptor Ditch, characterize flow and quality of groundwater collected by the drain, and to monitor flow and quality of water discharging from the Building 850 parking lot. The flow and quality of the South Interceptor Ditch and the Building 850 runoff will be evaluated by monitoring four existing surface water stations along the South Interceptor Ditch and by establishing four stations in the channels and culvert channeling flow from the Building 850 parking lot.

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

LIST OF FIGURES

LIST OF TABLES

LIST OF ACRONYMS

CDH	Colorado Department of Health
CLP	Contract Laboratory Program
cm/s	centimeters per second
DOE	U.S. Department of Energy
EMD	Environmental Management Division
EPA	U.S. Environmental Protection Agency
ER	Environmental Restoration
GRRASP	General Radiochemistry and Routine Analytical Services Protocol
IAG	Inter-Agency Agreement
IHSS	Individual Hazardous Substance Site
IM/IRA	Interim Measure/Interim Remedial Action
IRAP	Interim Remedial Action Plan
NPDES	National Pollution Discharge Elimination System
OP	Operating Procedure
OU1	Operable Unit No. 1
PA	perimeter area
PVC	polyvinyl chloride
QA/QC	Quality Assurance/Quality Control
QAPjP	Quality Assurance Project Plan
RCRA	Resource Conservation and Recovery Act
RFEDS	Rocky Flats Environmental Database System
SID	South Interceptor Ditch
TAL	Target Analyte List
TCL	Target Compound List
UV/H_2O_2	ultraviolet/hydrogen peroxide

SECTION 1
INTRODUCTION

1.1 PURPOSE

This document is the performance monitoring plan for the french drain that has been constructed as part of the Interim Measures/Interim Remedial Action (IM/IRA) for the 881 Hillside Area (Operable Unit No. 1 [OU1]) at the Rocky Flats Plant. The monitoring program is designed to provide information on the groundwater intercepted by the french drain, to determine the potential for migration of contaminated groundwater around or under the french drain, and to characterize the flow and water quality in the South Interceptor Ditch (SID) downgradient of the french drain. The U.S. Department of Energy (DOE) has implemented this IM/IRA to minimize the migration of hazardous substances in alluvial groundwater from OU1 that pose a potential long-term threat to the public health and environment. Data generated pursuant to this plan will allow evaluation of the effectiveness of the french drain in capturing contaminated alluvial groundwater and preventing further downgradient contaminant migration.

1.2 OU1 INTERIM MEASURE/INTERIM REMEDIAL ACTION OVERVIEW

The IM/IRA is part of a comprehensive, phased program of site characterization, remedial investigations, feasibility studies, and remedial/corrective actions currently in progress at the Rocky Flats Plant. These investigations are pursuant to the DOE Environmental Restoration (ER) Program, and the Federal Facility Agreement and Consent Order (known as the Inter-Agency Agreement [IAG]). In accordance with the agreement, the Rocky Flats Plant has been subdivided into 16 operable units for prioritized implementation of remedial investigations, feasibility studies, and remedial actions. OU1 has been given the highest priority because of the presence of high concentrations of volatile organic compounds in alluvial groundwater at the area, and its proximity to Woman Creek, which drains the southern part of the Rocky Flats Plant facility. A remedial investigation and feasibility study, which is currently in progress, will determine the full nature and extent of contamination, and the final remedy for the area.

The OU1 IM/IRA involves construction of a french drain (trench) to intercept contaminated alluvial/colluvial groundwater from the 881 Hillside Area. The french drain which is 1,435 feet long and is keyed into bedrock in order to fully penetrate the alluvium (Figure 1-1).

The downstream face of the french drain is covered with a synthetic membrane. The inclusion of the downstream synthetic membrane coupled with the continuity of the drain provides positive cutoff of the alluvial groundwater. A polyvinyl chloride (PVC) collection pipe inside the drain directs flow under gravity to a 6-foot wide collection gallery sump (Figure 1-1). The sump is equipped with a submersible sump pump to deliver the water from the drain to a new treatment plant.

Groundwater is also collected from a collection well at the base of Individual Hazardous Substance Site (IHSS) 119.1 ("source well"), and is pumped to the french drain collection sump (Figure 1-1). In addition, contaminated groundwater discharged from the Building 881 footing drain is piped directly into the french drain (Figure 1-1). The source well and footing drain flows commingle with alluvial groundwater collected by the french drain. Flow/volume measuring devices will be installed on the source well and footing drain discharge lines to monitor flow contributions from these sources.

The collected groundwater is treated using an ultraviolet/hydrogen peroxide (UV/H_20_2) system (for organics removal) and an ion exchange system (for inorganics removal). The water treatment system is enclosed in Building 891 to protect weather- or temperature-sensitive components. Following treatment, the water is directed to an effluent storage tank for sampling and analysis prior to discharging to the SID. Water discharged from the treatment system enters Pond C-2.

1.3 PROJECT BACKGROUND

The Interim Measures/Interim Remedial Action Plan (IRAP) (EG&G, 1990a) specified construction of an additional 500-foot segment of drain further west of the present western terminus (Station 5 + 00). The drain was shortened on the western end for the following reasons:

- Slope instability caused by further construction of the french drain would have also posed significant health and safety risks for personnel working within the trench excavation.

- Further construction would jeopardize the stability of the hillside and place stresses on the gas transmission line in this area. Test pits dug at 100 feet intervals west of the present western terminus encountered saturated alluvium, including artesian conditions at one location. It was felt that continued construction would undermine the foundation of the hillside and promote conditions favorable to slumping.

- Further construction of the french drain to the west was also hindered by slope stability. The saturated soils were continuously slumping into the excavation.

- Groundwater modeling showed that any contaminated groundwater originating from an IHSS within OU1 would effectively be captured by the drain at its present western terminus. (The modelling documentation and flow nets are included in Appendix A). The monitoring plan presented in this document should confirm this determination.

- The additional 500-foot segment of the drain would capture clean groundwater, which would significantly dilute contaminated waters collected by the drain and result in less effective removal of contaminants by the treatment plant.

The west end of the french drain collection pipe has been capped; however, should there be a need to lengthen the french drain to the west, the cap can be easily removed for the expansion.

The IRAP also specified the eastern end of the french drain be constructed 150 feet further to the east; however, the drain was shortened because wells east of this point have historically been dry, and continued construction to the east would have required crossing a gas line.

This monitoring plan was specifically requested by the Environmental Protection Agency (EPA)and the Colorado Department of Health (CDH) during a meeting with DOE and EG&G personnel on 26 March 1992. The agencies required that a program be established to evaluate the effectiveness of the french drain, and preparation and implementation of the monitoring plan was a condition for approving the western terminus location at station 5 + 00. This monitoring plan addresses the concerns of CDH and EPA regarding the potential for alluvial groundwater migration around the drain. It also presents plans to monitor alluvial groundwater flow, if any, beneath the drain in shear planes, bedrock, sandstones, and weathered claystone. Furthermore,

the plan is designed to characterize flow and water quality of the South Interceptor Ditch, characterize flow and quality of groundwater collected by the drain, and to monitor flow and quality of water discharging from the Building 850 parking lot.

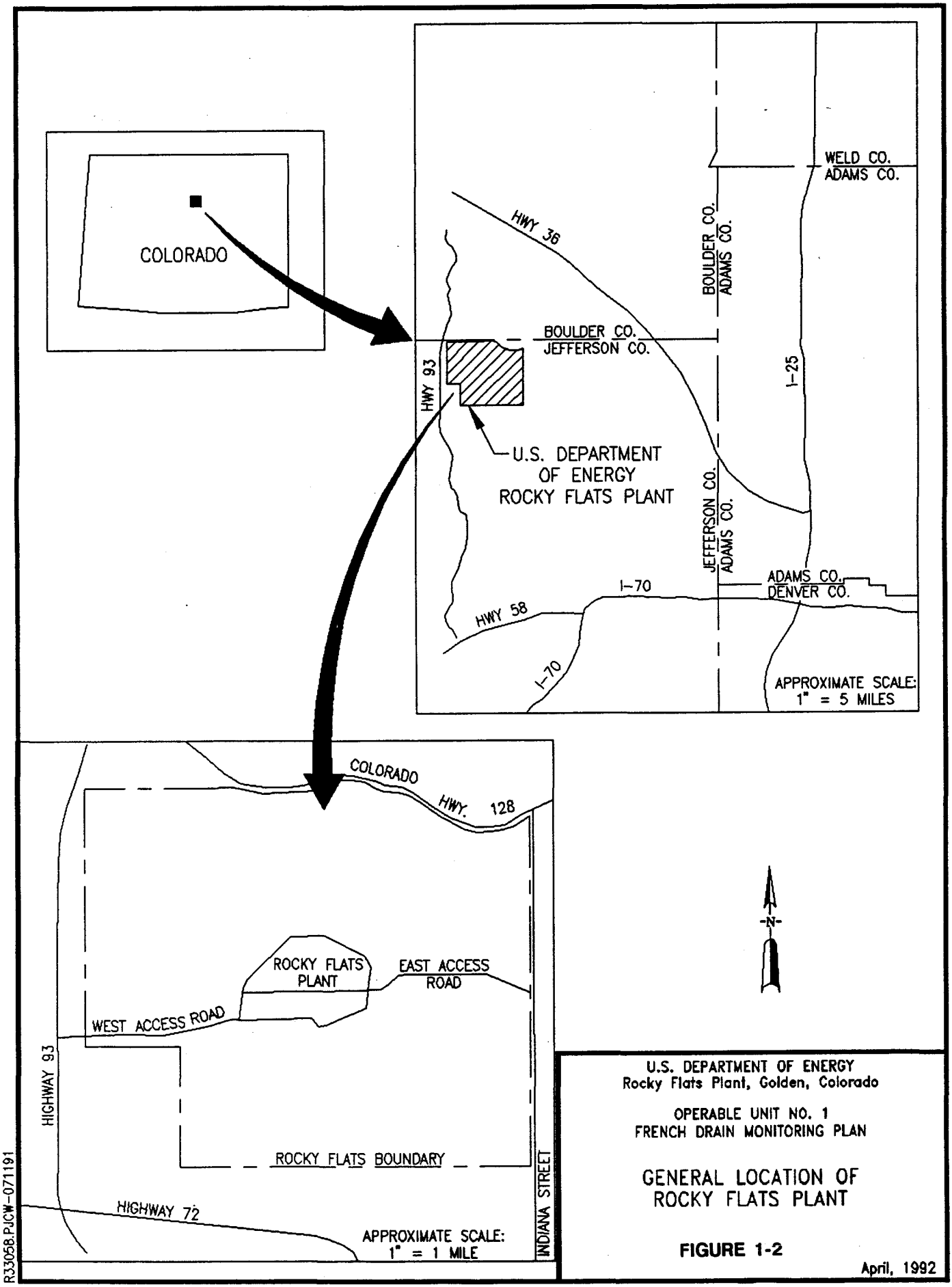
1.4 SITE LOCATION AND DESCRIPTION

1.4.1 Location and Facility Type

The Rocky Flats Plant is located in northern Jefferson County, Colorado, approximately 16 miles northwest of downtown Denver (Figure 1-2). The Plant site consists of approximately 6,550 acres of federally owned land in Sections 1 through 4, and 9 through 15, of T2S, R70W, 6th principal meridian. Major buildings are located within an area of approximately 400 acres, known as Rocky Flats Plant perimeter area (PA). The PA is surrounded by a buffer zone of approximately 6,150 acres.

The Rocky Flats Plant is a government-owned, contractor-operated facility. It is part of a nationwide nuclear weapons research, development, and production complex administered by the Albuquerque Operations Office of DOE; the operating contractor for the Rocky Flats Plant is EG&G. The facility has been in operation since 1951, and manufactures components for nuclear weapons and fabricates components from plutonium, uranium, beryllium, and stainless steel. Production activities include metal fabrication, machining, and assembly. Both radioactive and nonradioactive wastes are generated in the process. Current waste handling practices involve on-site and off-site recycling of hazardous materials and off-site disposal of solid radioactive materials at other DOE facilities.

The Rocky Flats Plant is currently an interim status Resource Recovery and Conservation Act (RCRA) hazardous waste treatment/storage facility. In the past, both storage and disposal of hazardous and radioactive wastes occurred at on-site locations.



U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant, Golden, Colorado

OPERABLE UNIT NO. 1
FRENCH DRAIN MONITORING PLAN

GENERAL LOCATION OF
ROCKY FLATS PLANT

FIGURE 1-2

April, 1992

1.4.2 OU1 (881 Hillside) Area Description

There are 12 sites designated as Individual Hazardous Substance Sites (IHSS) that comprise the OU1 Area, which is located at the southeast corner of the Rocky Flats Plant (Figure 1-3). A brief description of each site in the OU1 Area is presented below.

1. **Oil Sludge Pit (IHSS 102)** — A small pond located south of Building 881 was used for disposal of oil sludges in the late 1950s.

2. **Chemical Burial Site (IHSS 103)** — A small pit was used for disposal of liquid wastes southeast of Building 881 in the early 1960s.

3. **Liquid Dumping (IHSS 104)** — An area east of Building 881 was reportedly used for disposal of unknown liquids prior to 1969. This was not substantiated by results of drilling the area in 1987.

4, 5. **No. 6 Fuel Oil Tanks (IHSSs 105.1 & 105.2)** — Two fuel oil tanks are located south of Building 881; they are out of service and filled with concrete.

6. **Outfall Site (IHSS 106)** — An overflow line from the sanitary sewer sump south of Building 881 daylights on the slope below the building.

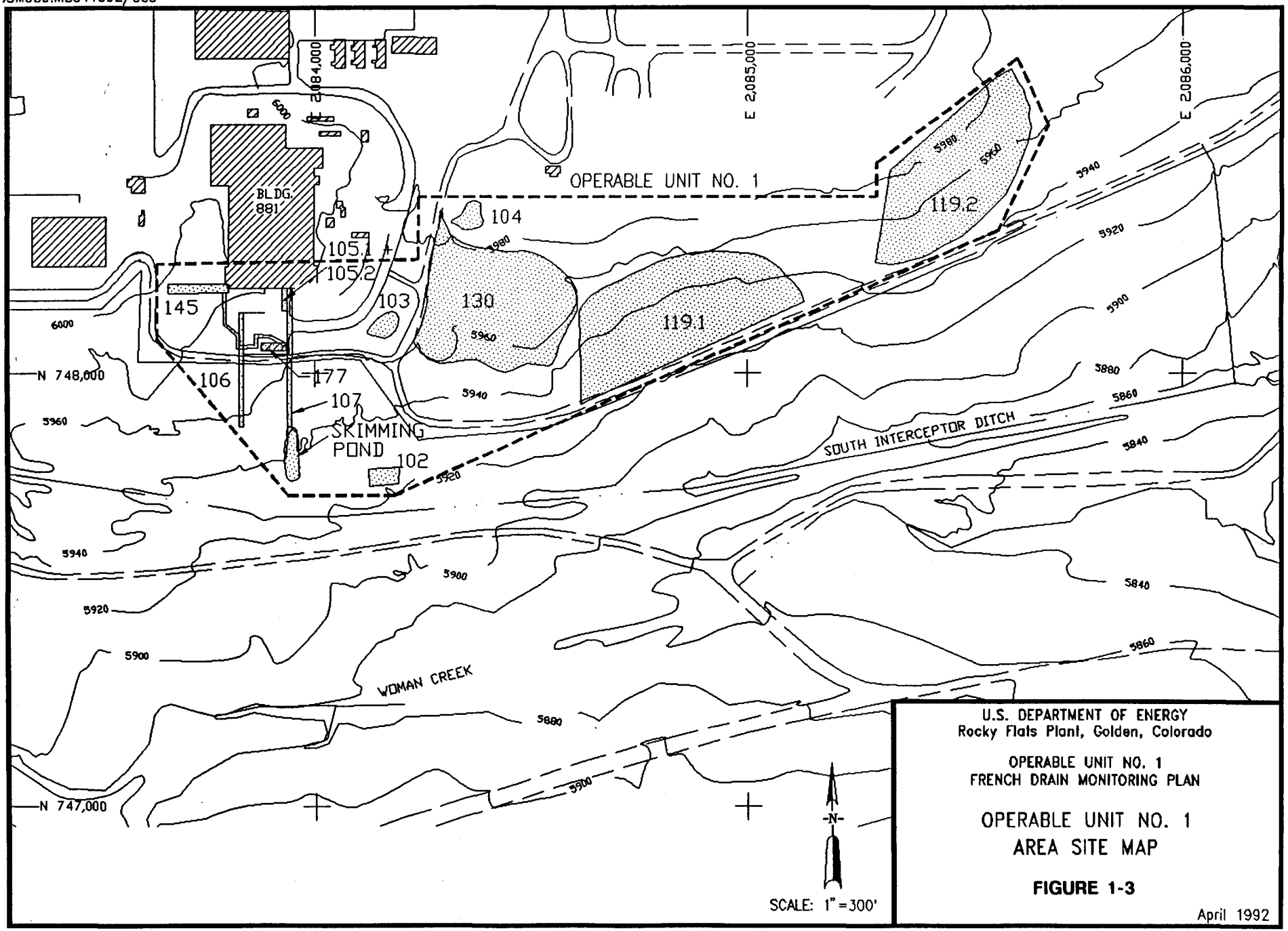
7. **Hillside Oil Leak (IHSS 107)** — Oil was discovered flowing from the Building 881 footing drain in early 1973. The source of the oil was never positively identified, but the oil was collected in a skimming pond and transported off site. There is an ongoing discharge of water from the footing drain.

8, 9. **Multiple Solvent Spills (IHSSs 119.1 & 119.2)** — Two areas east of Building 881 were used for barrel storage between 1969 and 1972.

10. **Radioactive Site (IHSS 130)** — Soils contaminated with low levels of radionuclides were placed on the hillside east of Building 881 and covered with soil between 1969 and 1972.

11. **Sanitary Sewer Line Leak (IHSS 145)** — The sanitary sewer line leaked on the hillside southwest of Building 881 in early 1981.

12. **Drum Storage Area (IHSS 177)** — Building 885, located south of Building 881, is currently used for satellite collection and 90-day accumulation of RCRA-regulated wastes. The building will be closed and soil remediation addressed under RCRA Interim Status (6 CCR 1007-3).



U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant, Golden, Colorado

OPERABLE UNIT NO. 1
FRENCH DRAIN MONITORING PLAN

OPERABLE UNIT NO. 1
AREA SITE MAP

FIGURE 1-3

April 1992

1.5 OBJECTIVES

The specific objectives to be met by implementation of this Performance Monitoring Plan are as follows:

- Confirm that the termination of the drain on the west end meets the objectives of the IM/IRA.
- Characterize groundwater flow and contaminant migration along the entire length of the french drain to evaluate the effectiveness of this interim action.
- Characterize groundwater quality and flow intercepted by the french drain.
- Characterize footing drain water quality and flow.
- Characterize flow and water quality in the SID downgradient of the french drain.
- Characterize flow of runoff from the Building 850 west parking lot (Figure 1-4).

The last objective, a specific request of the U.S. Environmental Protection Agency (EPA) and the Colorado Department of Health (CDH), is to determine the contribution of flow and any contamination arising from the Building 850 parking lot runoff that enters the SID upstream of the french drain. This area is not a part of OU1.

SECTION 2
FRENCH DRAIN PERFORMANCE MONITORING PLAN

This plan provides the framework for monitoring the effectiveness of the french drain constructed at the 881 Hillside to intercept alluvial groundwater. The monitoring program is designed to provide information on the groundwater intercepted by the french drain, to determine the potential for migration of contaminated groundwater around or under the french drain, and to characterize the flow and water quality of the SID downgradient of the french drain. Sampling stations for the monitoring program are shown in Table 2-1.

2.1 GROUNDWATER MONITORING

A network of monitoring wells will be installed to aid in the evaluation of the effectiveness of the french drain. The following sections describe the proposed sampling locations, procedures for the drilling and installation of the monitoring wells, and the methodologies for the collection of the groundwater samples and the proposed analytical plan.

2.1.1 Monitor Well Locations

Eleven new and 2 existing monitoring wells, which are located along the french drain alignment between the french drain and the SID, will be used to evaluate the potential for contaminated groundwater flow around or beneath the system. The two existing wells were installed subsequent to the construction of the french drain (MW-1 and MW-2) and are included as sampling locations in this monitoring plan. The proposed and existing well locations are presented in Figure 2-1; Table 2-2 summarizes the rationale for the placement of each well.

As illustrated in Figure 2-1, one monitoring well (FD01A) will be installed approximately 75 feet east of the eastern truncation of the french drain to monitor alluvial groundwater levels and quality at this end of the drain. Existing alluvial well MW-1 is located below the Building 881 footing drain outfall. This is an area that historically has had saturated alluvium. The outfall no longer exists as this flow is now transferred directly to the french drain. Wells FD02A and

Table 2-1

French Drain Monitoring Program
Sampling Stations

GROUND WATER*	
Alluvial Wells	Bedrock Wells
FD01A (Proposed)	
FD02A (Proposed)	FD02B (Proposed)
FD03A (Proposed)	FD03B (Proposed)
FD04A (Proposed)	
FD05A (Proposed)	
FD08A (Proposed)	FD06B (Proposed)
FD09A (Proposed)	FD07B (Proposed)
MW01 (Existing)	
MW02 (Existing)	

SURFACE WATER

SW-35 (Existing)
SW-36 (Existing)
SW-38 (Existing)
SW-70 (Existing)
Building 850 Parking Lot
- 3 concrete-lined channels (Proposed)
- Concrete culvert (Proposed)

FRENCH DRAIN

Building 881 Footing Drain Sump (Existing)
Valve Vault (Existing)
Sump #1 (Existing)

*See Figure 2-1 for locations and Table 2-2 for rationale.

Table 2-2

Proposed French Drain Monitoring Program
Monitor Wells

Well No.[a]	Station No.[b]	Monitoring Well Type	Rationale for Monitoring Well Installation and Location
FD01A	20 + 35	Alluvial[c]	To monitor any alluvial groundwater migrating around the eastern terminus of the drain.
FD02A	8 + 00	Alluvial[c]	To evaluate the effectiveness of the french drain in collecting alluvial groundwater.
FD02B	8 + 00	Bedrock[d]	To monitor for presence and quality of groundwater in shallow bedrock where *in situ* permeability tests were not performed during french drain construction.
FD03A	5 + 15	Alluvial[c]	To evaluate the effectiveness of french drain and to monitor for the presence and quality of water in shear planes.
FD03B	5 + 15	Bedrock[d]	To monitor for presence and quality of groundwater in shallow bedrock where *in situ* permeability tests were not performed during french drain construction.
FD04A	4 + 25	Alluvial[c]	To monitor any alluvial groundwater migrating around the western terminus of the system.
FD05A	3 + 25	Alluvial[c]	To monitor any alluvial groundwater migrating around the western terminus of the system.
FD06B	10 + 45	Bedrock[d]	Monitor for the presence and quality of groundwater in sandstone lense beneath the drain that was observed during the construction.
FD07B	6 + 40	Bedrock[d]	To monitor for presence and quality of groundwater in shallow bedrock where *in situ* permeability tests were not performed during french drain construction.
FD08A	14 + 75	Alluvial[c]	To monitor for the presence and quality of water in shear planes.
FD09A	17 + 75	Alluvial[c]	To monitor for the presence and quality of water in shear planes.

[a]See Figure 2-1 for proposed location.
[b]Relative to surveyed station locations.
[c]Alluvial wells will be constructed with the screen interval extending approximately 0.5 feet into bedrock (Section 2.1.2).
[d]Bedrock wells will be installed as described in Section 2.1.2.

FD03A will be installed to confirm capture of any potential alluvial groundwater along this segment of the drain.

Wells FD04A and FD05A are located beyond the western terminus of the french drain in order to characterize alluvial groundwater flow and any contamination that is not intercepted by the drain. In addition, the regulatory agency approval for the western termination of the french drain (as depicted in Figure 2-1) requires that these wells be installed to monitor groundwater conditions at this end of the drain. This information will be used to determine if a future extension of the existing french drain system may be required.

Shear planes beneath slump blocks were observed in the french drain excavation at Stations 5 + 15, 14 + 75, and 17 + 75. These shear planes extend beneath the bottom of the french drain; however, the french drain excavation extended deeper than the elevation of these shear planes and was backfilled with grout in each location. Therefore, wells FD03A, FD08A, and FD09A will be drilled to investigate the potential for ground migration in these shear planes.

Permeability tests were not performed in the bedrock between Stations 10 + 45 and 5 + 00 during construction of the french drain. These tests were intended to confirm that the base of the excavation extended into bedrock with a 10^{-6} centimeters per second (cm/s) hydraulic conductivity (hydraulic conductivity values in bedrock for stations along the trench are presented in Appendix B.) Therefore, bedrock wells FD02B, FD03B, and FD07B will be paired with the alluvial wells that are immediately downgradient of the french drain to monitor groundwater where *in situ* hydraulic conductivity data were not collected.

Well FD06B will be installed near Station 10 + 45 where a sandstone was encountered during excavation of the drain. The vertical and horizontal extent of the sandstone is unknown; therefore, the well may not be installed if the sandstone is not encountered during drilling.

2.1.2 Monitor Well Drilling and Installation

Each of the proposed french drain monitoring wells will be installed using drilling equipment capable of obtaining continuous samples. The boreholes for well installation will be drilled to various depths as described in Table 2-3. The core retrieved during the drilling will be screened for total organic vapors using appropriate field instrumentation and then detailed lithologic descriptions of each sample will be recorded by the field geologist in the project-specific field logbook. All drilling and logging procedures will be performed in accordance with the applicable Environmental Management Division (EMD) Operating Procedures (OP) (EG&G, 1991a, 1991b, 1992a, and 1992b). Samples will be collected from F02B, GD03B, and FD07B at a depth corresponding to the depth of the french drain excavation near the borehole for back pressure permeability testing. This information will be used to confirm that the french drain is indeed keyed into appropriate material to prohibit alluvial groundwater flow beneath the drain.

Alluvial and bedrock monitoring wells will be installed in accordance with the designs presented in OP GT.6 (EG&G, 1992a). The monitoring wells will be designed as follows:

- Alluvial wells (FD01A, FD02A, FD03A, FD04A, FD05A, FD08A, and FD09A) will be drilled using a hollow-stem system augers to advance the borehole. The boreholes will be terminated approximately 2 feet below the bedrock contact and the bottom 6 inches of the borehole will be backfilled with bentonite pellets. The casing-screen assembly will consist of a 1.5-foot sediment sump overlain by slotted PVC well screen and PVC well casing. The bottom of the screen will be placed approximately one-half foot below bedrock and will extend to a depth of 4.5 to 5 feet below ground surface. A sand pack will be emplaced from the base of the borehole to 0.5 feet to 2 feet above the screen. A minimum of 2 feet of bentonite seal will be placed above the sand, followed by bentonite grout. If no glide planes are found in boreholes for FD08A and FD09A, the boreholes will be abandoned by grouting the borehole to the surface.

Table 2-3

Proposed Monitor Well Construction

Proposed Monitored Well	Anticipated Depth to Shear Plane	Anticipated Depth to Bedrock	Anticipated Total Depth	Anticipated Screen Interval
FDO1A[a]	NA	18.0	20.5	5.0 - 18.5
FDO2A	NA	22.0	24.5	5.0 - 22.5
FD02B	NA	22.0	32.0	25.0 - 30.0
FD03A	19.0	29.0	31.5	5.0 - 29.5
FD03B	NA	29.0	39.0	32.0 - 37.0
FD04A[a]	NA	29.0	31.5	5.0 - 29.5
FD05A[a]	NA	20.0	22.5	5.0 - 20.5
FD06B	NA	33.0 (48.0[b])	54.0	47.0 - 52.0
FD07B	NA	24.0	34.0	27.0 - 32.0
FD08A	24.0	24.0	26.5	5.0 - 24.5
FD09A	19.0	19.0	21.5	5.0 - 19.5

[a]This well is located beyond the reach of the french drain excavation; therefore, no precise information is available at this time to determine the depth to bedrock, etc.

[b]The anticipated depth to the sandstone unit. This depth has been extrapolated from information obtained during the french drain excavation.

NA Not anticipated.

- Bedrock wells (FD02B, FD03B, and FD07B) will be drilled with a hollow-stem auger rig to advance the borehole 10 feet into bedrock. The bottom 6 inches of the borehole will be backfilled with bentonite pellets. The casing-screen assembly will consist of a 1.5-feet sediment sump overlain by slotted PVC well screen and PVC well casing. Screen length will be 5 feet and will extend from approximately 3 feet to 8 feet below the bedrock contact. Sand pack will be emplaced from the base of the borehole to 1 foot above the screen. A minimum of 2 feet of bentonite seal will be placed above the sand, followed by bentonite grout to the surface.

- The alluvial portion of the borehole drilled for installation of the bedrock sandstone well (FD06B; previously FD06C) will be drilled using hollow stem augers. Surface casing will then be grouted in place and allowed to set for 8 hours. The borehole will then be advanced approximately 2 feet beyond the base of the sandstone using a rig capable of coring. The bottom 6 inches of the borehole will be backfilled or filled with bentonite pellets. The casing-screen assembly will consist of a 1.5-foot sediment sump overlain by slotted PVC well screen and PVC well casing. Screen will straddle the entire sandstone unit. A sand pack will be emplaced from the base of the boring to 0.5 feet to 1 foot above the screen. A minimum of 2 feet of bentonite seal will be placed above the sand, followed by bentonite grout to the surface.

Following installation, each of the monitoring wells will be developed to ensure proper hydraulic connection between the screened interval and the monitored formation. Well development procedures will follow the methods presented in OP GW.02 (EG&G, 1991b).

2.1.3 Sample Collection

Groundwater samples will be collected from each of the french drain monitoring wells subsequent to development. The wells will be sampled quarterly throughout the duration of the IM/IRA. Water level measurements will be obtained weekly at all new wells, at MW-1 and MW-2, at upgradient wells 4887 and 35691, and at 31491 and 4787, which are downgradient

of the drain. Measurements will continue for two quarters or until water measurements stabilize. Readings will be taken using an electric sounding device before sampling commences to determine the volume of water in each well and to provide the information necessary to map the potentiometric surface to illustrate the effects of the french drain on the groundwater flow system. Water level measurements will follow the procedures outlined in OP GW.01 (EG&G, 1991b).

Prior to sampling, at least 3 casing volumes of water will be removed from the well to ensure that representative formation water is sampled. Field water quality parameters of temperature, conductivity, and pH will be measured during the presample purging. Sampling will take place when these parameters are observed to stabilize (OP GW.05) (EG&G, 1991b). All groundwater sampling procedures will be performed in accordance with OP GW.06 (EG&G, 1991b).

In addition to the investigative samples, quality assurance/quality control (QA/QC) samples will be collected during each sampling event. The frequency and type of QA/QC samples collected are specified in the Quality Assurance Project Plan (QAPjP) (EG&G, 1990b) and are discussed further in Section 2.4.

2.2 FRENCH DRAIN COLLECTION SYSTEM

The french drain collection system will be monitored to determine the quality of the groundwater being intercepted by the structure. Groundwater quality and quantity will be monitored for the Building 881 footing drain discharge, the source well discharge, and the french drain discharge. The french drain discharge represents the sum of the above noted flows and the alluvial groundwater directly intercepted by the drain. Flows from the source well and the french drain will be measured using totalizing meters. Flow from the Building 881 footing drain will be measured by a weir installed at the outlet of the footing drain sump. Continuously recorded water level measurements in the vault will be used to establish the flow and volume of water discharged from the footing drain.

2.2.1 Sample Locations

Water quality samples will be collected from the Building 881 footing drain, the source well, and the french drain discharges. The source well sample will be collected from the sample hydrant located at the collection well (Figure 1-3). The french drain discharge sample will be collected from the hydrant located at the french drain gallery collection sump (Sump #1) and the footing drain discharge sample will be collected from the footing drain sump. Special attachments, including one-quarter-inch tubing, will be fixed to the outlet of the hydrants in order to prevent aerating the samples for volatile organic analysis.

2.2.2 Sample Collection

Grab samples from the footing drain vault will be collected by lowering a bailer attached to a rope. Samples will be collected from the hydrant located at the collection well and the collection well sump via the existing valve system.

2.3 SURFACE WATER MONITORING

Surface water monitoring of the SID and the Building 850 west parking lot will be conducted to evaluate the quality of the surface water system immediately downgradient of the french drain and to investigate the quantity and quality of water exiting the Building 850 west parking lot that discharges to the SID upstream of OU1.

2.3.1 South Interceptor Ditch

The SID intercepts surface water runoff from the plant and diverts the water around retention Pond C-1 for discharge into Pond C-2. There is currently a sitewide surface water monitoring program underway and several stations along the SID are included as sample locations for this program.

2.3.1.1 Sample Locations

Existing surface water stations along the SID will be used to investigate the water quality conditions down- and up-stream of the french drain. Stations SW38, SW36, and SW35 are located upgradient of the french drain within pooling areas in the SID (Figure 2-1). Station SW70 is located downgradient of the french drain and will provide information on the effect of the french drain on the SID water quality by comparing this data with information collected from the upgradient locations.

It is not proposed that flow rates be measured in the SID downstream of the french drain. The SID is an ephemeral system that exhibits flow only during storm events. Permanent surface water flow measuring weirs were proposed in the SID; however, due to the potential that the SID is a good habitat of the endangered plant species *Spiranthes*, such measuring devices have not been installed. The SID has also become silted-in and overgrown with vegetation in several stretches and, therefore, water ponds form in several areas during times of low flow. Actual flow only occurs in the SID during storm events and periods of runoff and snowmelt. The proposed sampling locations are located in these ponding areas to ensure that sufficient water will be available for water quality sampling. However, in order to gauge the flow exiting the SID, a gauging station is located above Pond C-2. Automatic flow monitors and water samplers have been installed to continuously monitor the flow and water quality of the SID during storm events resulting in discharge to Pond C-2.

2.3.1.2 Sample Collection

Surface water samples will be collected from each of the surface water stations described above on a quarterly basis as part of the sitewide surface water sampling program. The chemical data gathered from this program for each of these stations, along with the water quality and flow data collected from the SID gauging station at Pond C-2, will be used to evaluate SID water quality and flow relative to the operation of the french drain. Surface water sampling procedures will be performed in accordance with the appropriate OPs (SOP SW3, SW10, SW11, and SW14 ([EG&G, 1992b]).

2.3.2 West Parking Lot

According to EG&G personnel, runoff exits the west parking lot of Building 850. Discharge from the parking lot is from three V-shaped concrete channels that spill over the south border of the terrace where the Plant is situated. There is also a concrete culvert discharging runoff in the area. In conjunction with the proposed french drain monitoring program, EPA has requested that the flow and water quality of the runoff leaving the parking lot be monitored. A gauging station and automatic sampler will be installed in each of the channels and the culvert to continuously collect the requested data.

2.4 ANALYSIS PLAN

The samples collected from the french drain monitoring wells and collection system will be analyzed for Contract Laboratory Program (CLP) Target Compound List (TCL) organics including volatiles, semivolatile, and pesticide/PCBs. In addition, samples for analysis of CLP Target Analyte List (TAL) metals, radionuclides, and other inorganics will be collected during this monitoring program. Water samples will be analyzed in the field for pH, specific conductivity, and temperature. Surface water samples will be analyzed for the same parameters and will also be tested in the field for the dissolved oxygen content. The field and analytical parameters are presented in Table 2-4. All samples requiring filtration will be filtered in the field; all samples will be preserved in the field.

All analytical methods will follow the General Radiochemistry and Routine Analytical Services Protocol (GRRASP) (EG&G, 1990c). The CLP methods for CLP analytes are based on the EPA SW846 methods for analyzing wastewaters and solid wastes (EPA, 1986). Methods for anions and indicator parameters are based on EPA-developed or EPA-reviewed and approved methods sufficient to meet the data quality objectives. Radionuclide analytical methods have been either developed or reviewed and approved by EPA.

Quality control samples will be collected in conjunction with the investigative samples to provide information on data quality. Field (rinsate) blanks, trip blanks, field duplicates, laboratory

Table 2-4

Proposed French Drain Performance Monitoring Plan Sampling Parameters

Metals* Target Analyte List	Other
Aluminum Antimony Arsenic Barium Beryllium Cadmium Calcium Chromium Cobalt Copper Iron Lead Magnesium Manganese Mercury Nickel Potassium Selenium Silver Sodium Thallium Vanadium Zinc	**Field Parameters** pH Specific Conductance Temperature Dissolved Oxygen (surface water only) **Indicators** Total Dissolved Solids Total Suspended Solids (surface water only) **Anions** Carbonate Bicarbonate Chloride Sulfate Nitrate (as N) Cyanide
Other Metals	Radionuclides*
Molybdenum Strontium Cesium Lithium Tin	Gross Alpha Gross Beta Uranium - 233, 234, 235, and 238 Plutonium - 239, 240 Tritium Strontium - 89, 90

Table 2-4 (Continued)

Proposed French Drain Performance Monitoring Plan Sampling Parameters

Organics: Volatiles Target Compound List	Organics: SemiVolatiles Target Compound List
Chloromethane	Phenol
Bromomethane	bis(2-chloroethyl)ether
Vinyl Chloride	2-Chlorophenol
Chloroethane	1,3-Dichlorobenzene
Methylene Chloride	1,4-Dichlorobenzene
Acetone	Benzyl Alcohol
Carbon Disulfide	1,2-Dichlorobenzene
1,1-Dichloroethene	2-Methylphenol
1,1-Dichloroethane	bis(2-Chloroisopropyl)ether
total 1,2-Dichloroethene	4-Methylphenol
Chloroform	N-Nitroso-Dipropylamine
1,2-Dichloroethane	hexachloroethane
2-Butanone	Nitrobenzene
1,1,1-Trichloroethane	Isophorone
Carbon Tetrachloride	2-Nitrophenol
Vinyl Acetate	2,4-Dimethylphenol
Bromodichloromethane	Benzoic Acid
1,1,2,2-Tetrachloroethane	bis(2-Chloroethoxy)methane
1,2-Dichloropropane	2,4-Dichlorophenol
trans-1,3-Dichloropropane	1,2,4-Trichlorobenzene
Trichloroethene	Naphthalene
Dibromochloromethane	4-Chloroaniline
1,1,2-Trichloroethane	Hexachlorobutadine
Benzene	4-Chloro-3-methylphenol(para-chloro-meta-cresol)
cis-1,3-Dichloropropene	2-Methylnaphthalene
Bromoform	Hexachlorocyclopentadiene
2-Hexanone	2,4,6-Trichlorophenol
4-Methyl-2-pentanone	2,4,5-Trichlorophenol
Tetrachloroethene	2-Chloronaphthalene
Toluene	2-Nitroaniline
Chlorobenzene	Dimethylphthalate
Ethyl Benzene	Acenaphthylene
Styrene	3-Nitroaniline
Total Xylenes	Acenaphthene
	2,4-Dinitrophenol
	4-Nitrophenol
	Dibenzofuran

Table 2-4 (Continued)

Proposed French Drain Performance Monitoring Plan Sampling Parameters

Organics: Pesticides/PCBs Target Compound List	Organics: SemiVolatiles Target Compound List (Continued)
alpha-BHC	2,4-Dinitrotoluene
Beta-BHC	2,6-Dinitrotoluene
delta-BHC	Diethylphthalate
gamma-BHC (Lindane)	4-Chlorophenyl Phenyl ether
Heptachlor	Fluorene
Aldrin	4-Nitroaniline
Heptachlor Epoxide	4,6-Dinitro-2-methylphenol
Endosulfan I	N-nitrosodiphenylamine
Dieldrin	4-Bromophenyl Phenly ether
4,4-DDE	Hexachlorobenzene
Endrin	Pentachlorophenol
Endosulfan II	Phenanthrene
4,4-DDD	Anthracene
Endosulfan Sulfate	Di-n-butylphthalate
4,4-DDT	Fluoranthene
Endrin Ketone	Pyrene
methoxychlor	Butyl Benzylphthalate
alpha-Chlordane	3,3'-Dichlorobenzidine
gamma-Chlordane	Benzo(a)anthracene
Toxaphene	bis(2-ethylhexyl)phthalate
AROCLOR-1016	Chrysene
AROCLOR-1221	Di-n-octyl Phthalate
AROCLOR-1232	Benzo(b)fluoranthene
AROCLOR-1242	Benzo(k)fluoranthene
AROCLOR-1248	Benzo(a)pyrene
AROCLOR-1254	Indeno(1,2,3-cd)pyrene
AROCLOR-1260	Dibenz(a,h)anthracene
	Benzo(g,h,i)perylene

* Dissolved metals and radionuclides for ground water; total and dissolved metals and radionuclides for surface water.

blanks, laboratory replicates, and laboratory matrix spike and matrix spike duplicates are the commonly collected QC samples. Table 2-5 presents the suggested guidelines for collection of field QC samples (EPA, 1987) that are consistent with the guidelines listed in the QAPjP.

Trip blanks are prepared by the analytical laboratory and consist of sample containers filled with deionized water. The trip blanks are transported along with the sample containers to the organization performing the field investigation and are constantly kept with the investigative samples until the samples are analyzed by the contract laboratory. The purpose of trip blanks is to investigate the sample container integrity and the potential for samples becoming contaminated during transport to and from the laboratory. Trip blanks generally pertain to volatile organic analysis.

Field blanks (rinsate blanks) will be collected by pouring distilled/deionized water through decontaminated sample collection equipment and submitting the sample for the analysis of the same parameters as the investigative samples. Field (rinsate) blanks monitor the effectiveness of decontamination procedures. Field replicates will be collected and analyzed to provide information regarding the natural variability of the sampled media as well as evaluate analytical precision.

Laboratory blanks and replicates test analytical procedures and conditions. Laboratory matrix spikes and matrix spike duplicates measure analytical accuracy by providing data on matrix interferences and components interfering with instrument responses. The frequency of collection and analysis of laboratory QC samples is dictated by the prescribed analytical method as noted in the GRRASP.

The new wells and MW-1 and MW-2 will be sampled for two quarters for the full suite of analytes, and the same wells, excluding MW-2, will be sampled monthly for two quarters for total organic halogens. Upon the completion of two quarterly sampling events and receipt and validation of the analytical results, the data will be evaluated to determine if classes of compounds can be deleted from the analytical suite in future sampling events. Deletion of specific compounds from the monitoring program will not occur without the prior approval of EPA and CDH.

Table 2-5

Guidelines for Field Quality Control Sample Collection Frequency

Analytical Parameter	Trip Blank	Field (rinsate) Blank	Field Replicate
Volatile Organics	1 in 20	1 in 20	1 in 20
Metals	N/A	1 in 20	1 in 20
Radionuclides	N/A	1 in 20	1 in 20
TCL semivolatiles	N/A	1 in 20	1 in 20
TCL Pesticide/PCBs	N/A	1 in 20	1 in 20
Other	N/A	1 in 20	1 in 20

N/A — Not applicable.

SECTION 3

DATA MANAGEMENT AND REPORTING

Field and laboratory data collected during implementation of this monitoring program will be incorporated into the Rocky Flats Environmental Database System (RFEDS). Field data sheets will be completed in the field and a diskette containing the field information will be transmitted to the EG&G RFEDS Department for input. Analytical data from the EG&G contract laboratories will also be transmitted to EG&G via electronic file. A hard copy of the data will be submitted to the EG&G contract consultant (Quantalex, Inc.) for validation. Upon completion of the validation process, the data along with the appropriate validation codes will be input into RFEDS. Hard copy reports will then be generated from the system for data interpretation and evaluation.

Letter reports summarizing the data collected during each quarterly sampling event will be prepared and submitted to EPA and CDH for review and comment. In accordance with a request from EPA, this data will be submitted to the EPA Rocky Flats Groundwater Team, as well as the OU1 Project Manager. Preparation of the reports will be initiated upon receipt of the validated data from Quantalex. The reports will include a brief description of the field activities, tables summarizing the field and laboratory data, diskettes of data, and a discussion of the data. Figures will be included, as appropriate.

SECTION 4

REFERENCES

EG&G. 1990a. Interim Measures/Interim Remedial Action Plan and Decision Document, Operable Unit No. 1, Rocky Flats Plant. January 1990.

EG&G. 1990b. Draft Rocky Flats Plant Site-Wide Quality Assurance Project Plan for CERCLA Remedial Investigations/Feasibility Studies Activities, ER Program, Rocky Flats Plant, Golden, Colorado. August 1990.

EG&G. 1990c. General Radiochemistry and Routine Analytical Services Protocol (GRRASP), ER Program, Rocky Flats Plant, Golden, Colorado. September 1990.

EG&G. 1991a. Environmental Management Division Operating Procedures, Manual No. 5-21000-OPS-FO, Volume I: Field Operations. August 1991.

EG&G. 1991b. Environmental Management Division Operating Procedures, Manual No. 5-21000-OPS-GW, Volume II: Groundwater. August 1991.

EG&G. 1992a. Environmental Management Division Operating Procedures, Manual No. 5-21000-OPS-GT, Volume III: Geotechnical. February 1992.

EG&G. 1992b. Environmental Management Division Operating Procedures, Manual No. 5-21000-OPS-SW, Volume IV: Surface Water. February 1992.

EPA (U.S. Environmental Protection Agency). 1986. Methods for Chemical Analysis of Water and Wastes, SW 846 SOW.

EPA (U.S. Environmental Protection Agency). 1987. Data Quality Objectives for Remedial Response Activities; EPA 154-IG-871003, OSWER Directive 9355.0-7B. March 1987.

APPENDIX A

DOCUMENTATION OF GROUNDWATER MODELING FOR THE FRENCH DRAIN

881 HILLSIDE - FRENCH DRAIN

Preliminary Drawdown Model For West End of Drain

Model Used

USGS MODFLOW

Model Parameters

k 2.5 ft/day colluvial materials
2.5×10^{-3} ft/day drain liner

s 0.3

Dx 15 ft (60 columns)

Dy 15 ft nominal, 7.5 ft at drain liner (41 rows)

Boundary Conditions: constant head (5 ft) along max. and min. rows
no-flow along max. and min. columns

Initial Saturated Thickness: 5 ft

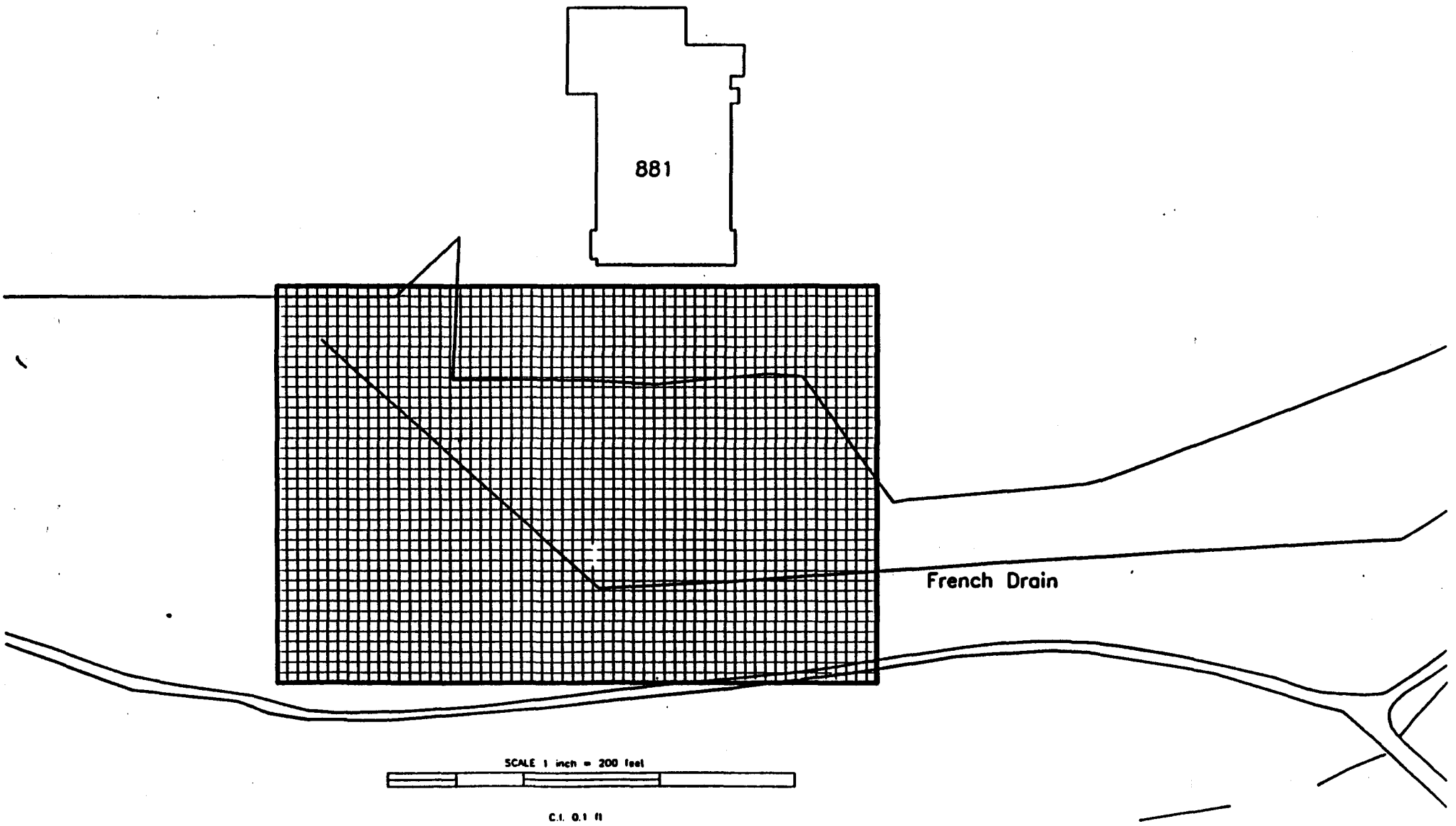
Drain Elevation: 1 ft above model base

Drain Conductance: 140 ft/day

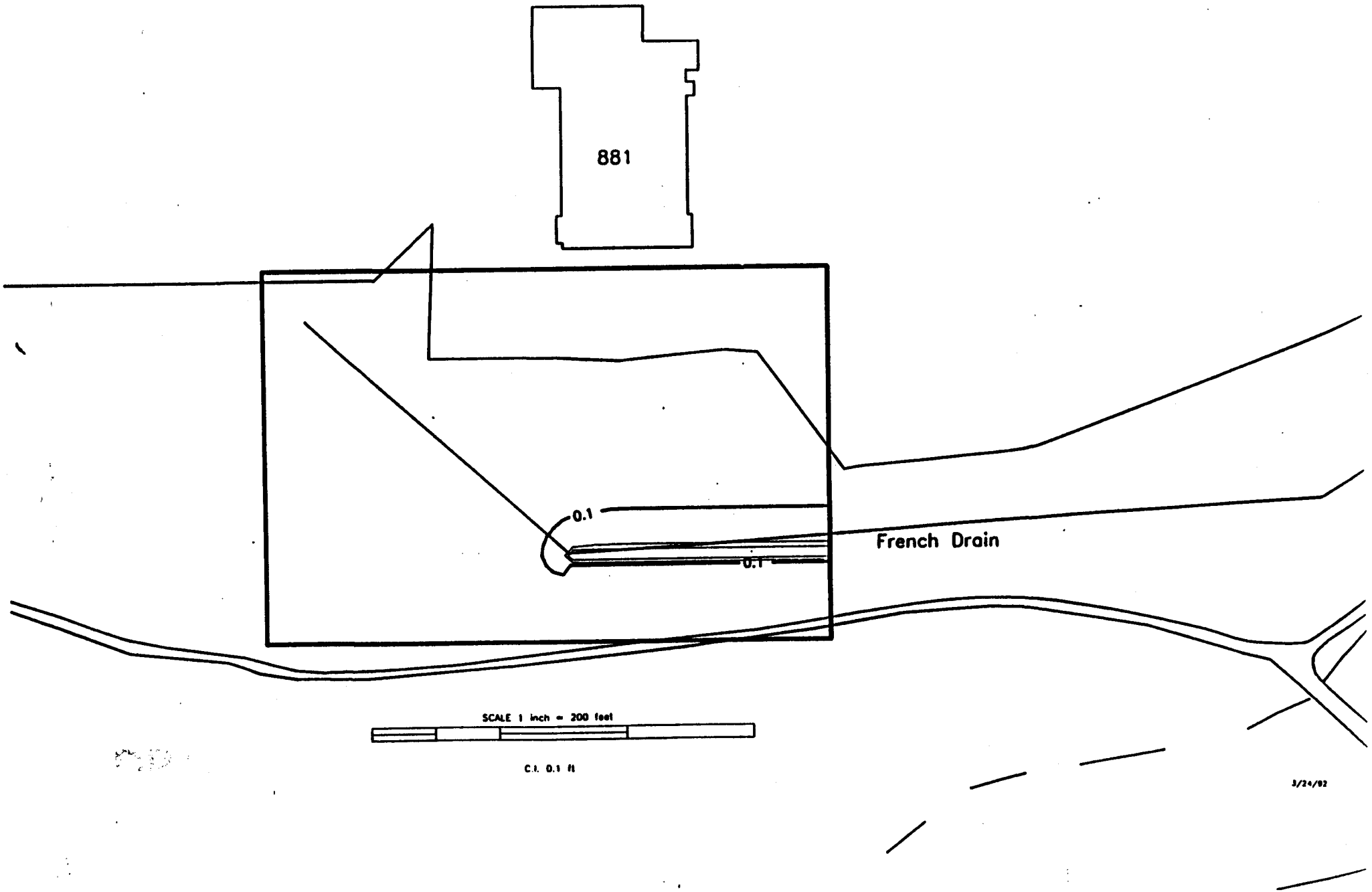
Drain Location: row 31, columns 33-60

Time Step Length: 14 days

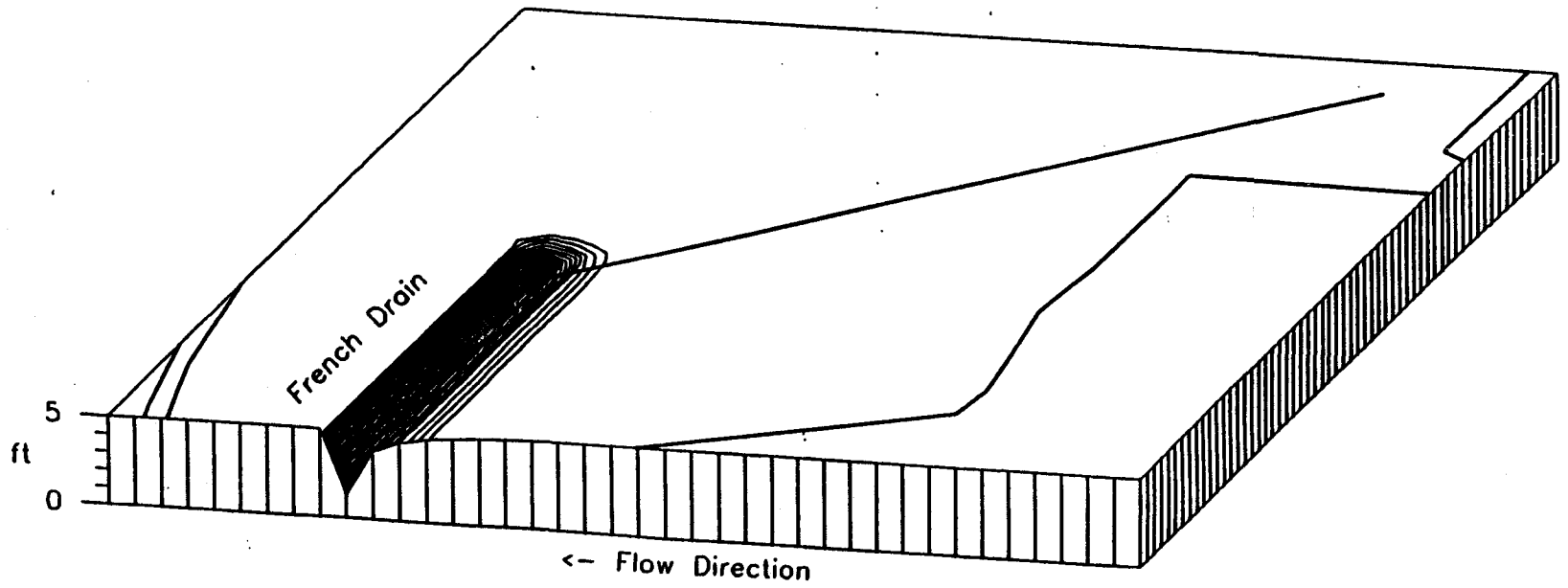
French Drain Model Domain



Modeled French Drain Drawdown at 14 Days



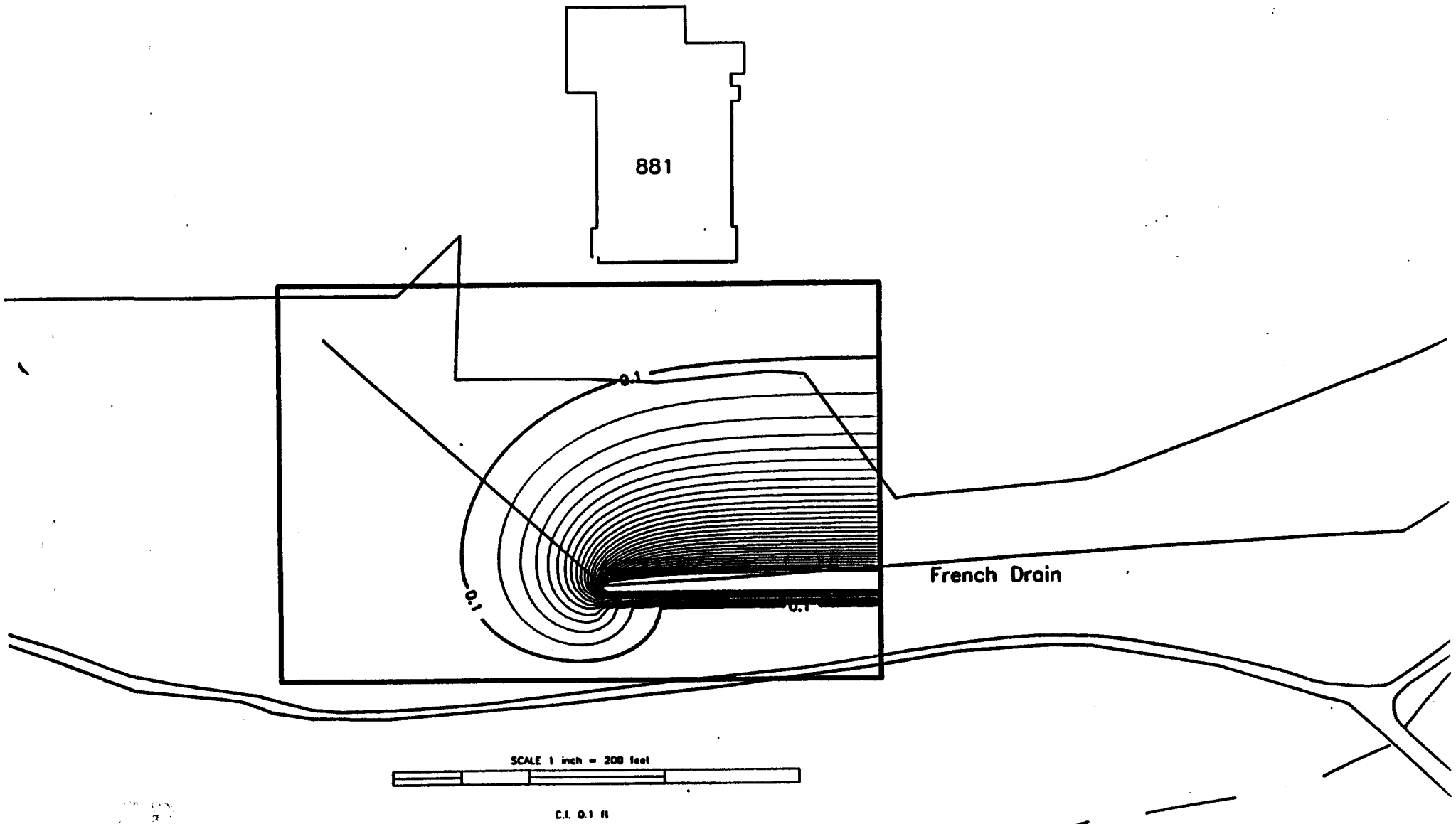
Modeled French Drain Water Table 14 Days



C.I. 0.1 ft

3/24/92

Modeled French Drain Drawdown at 1 Year



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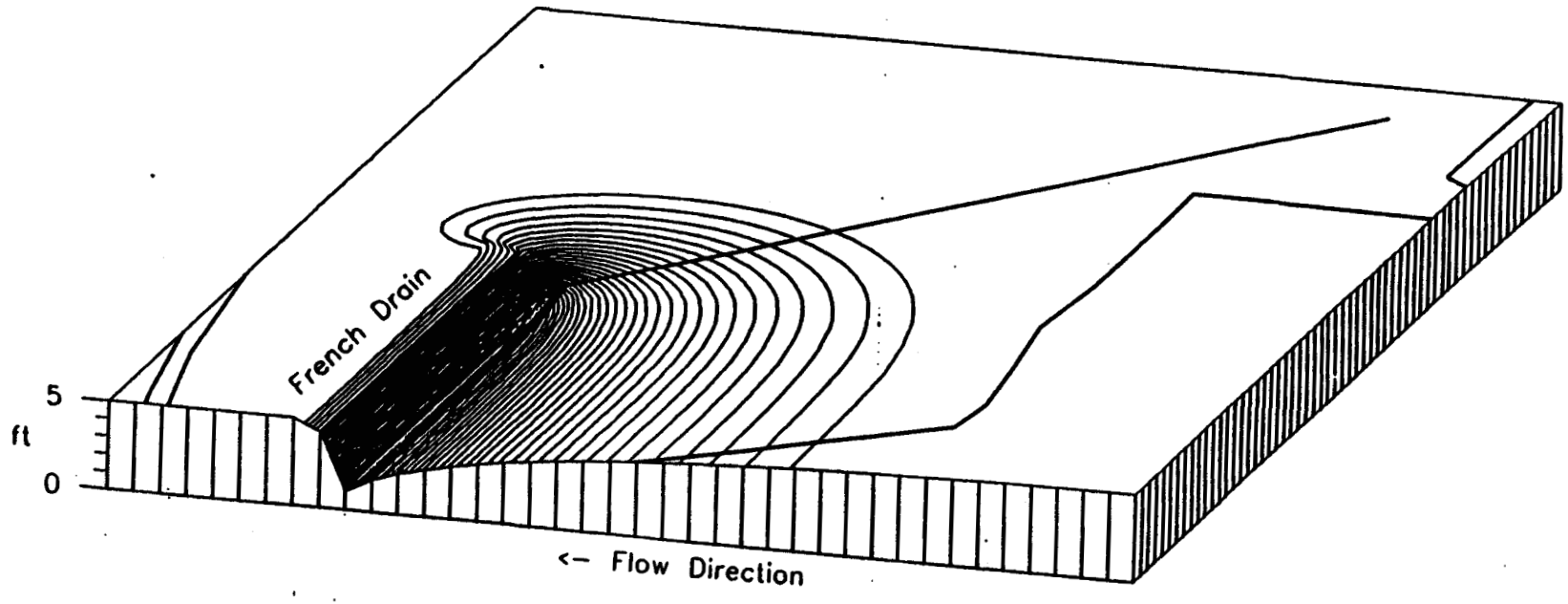
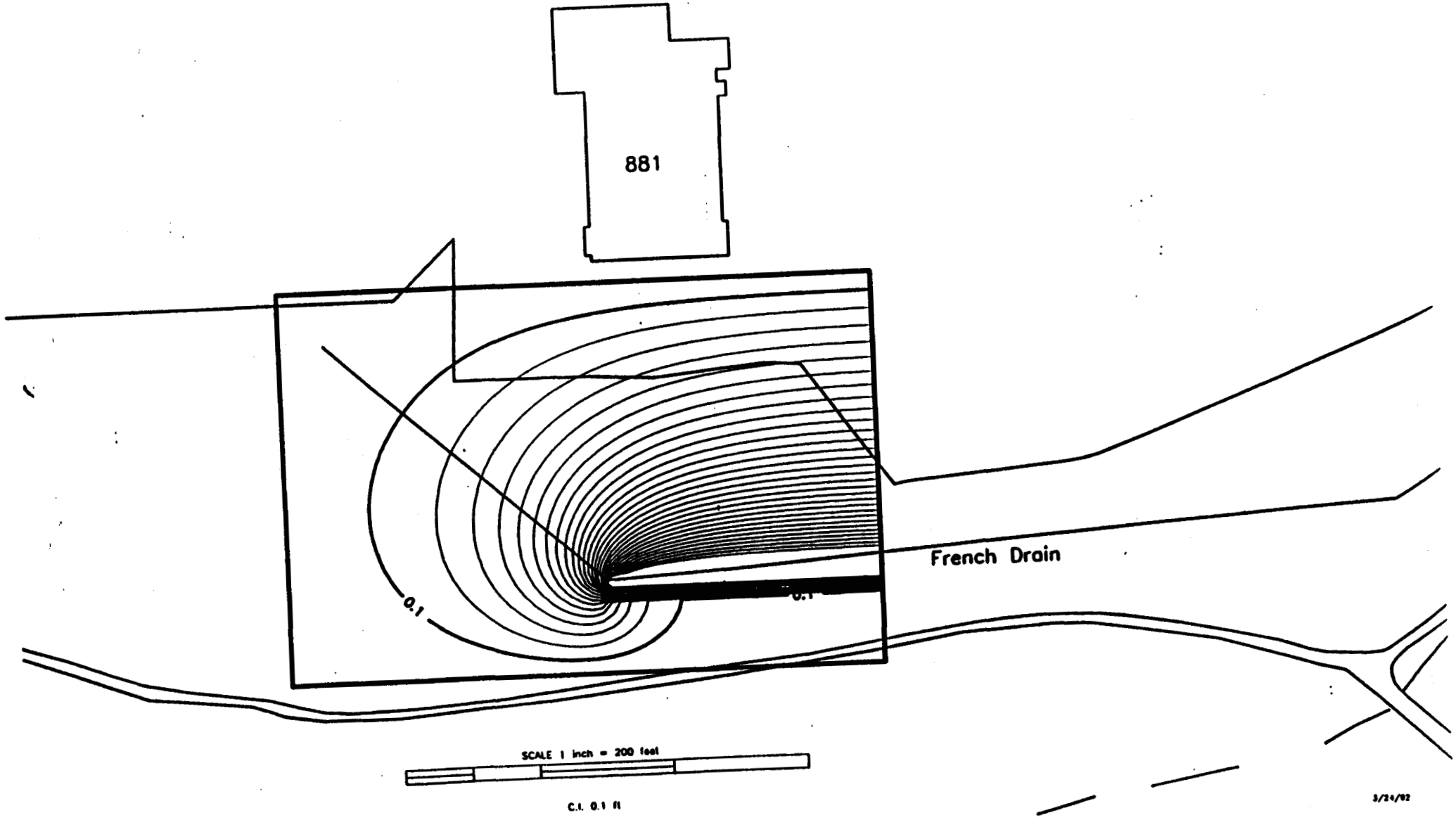


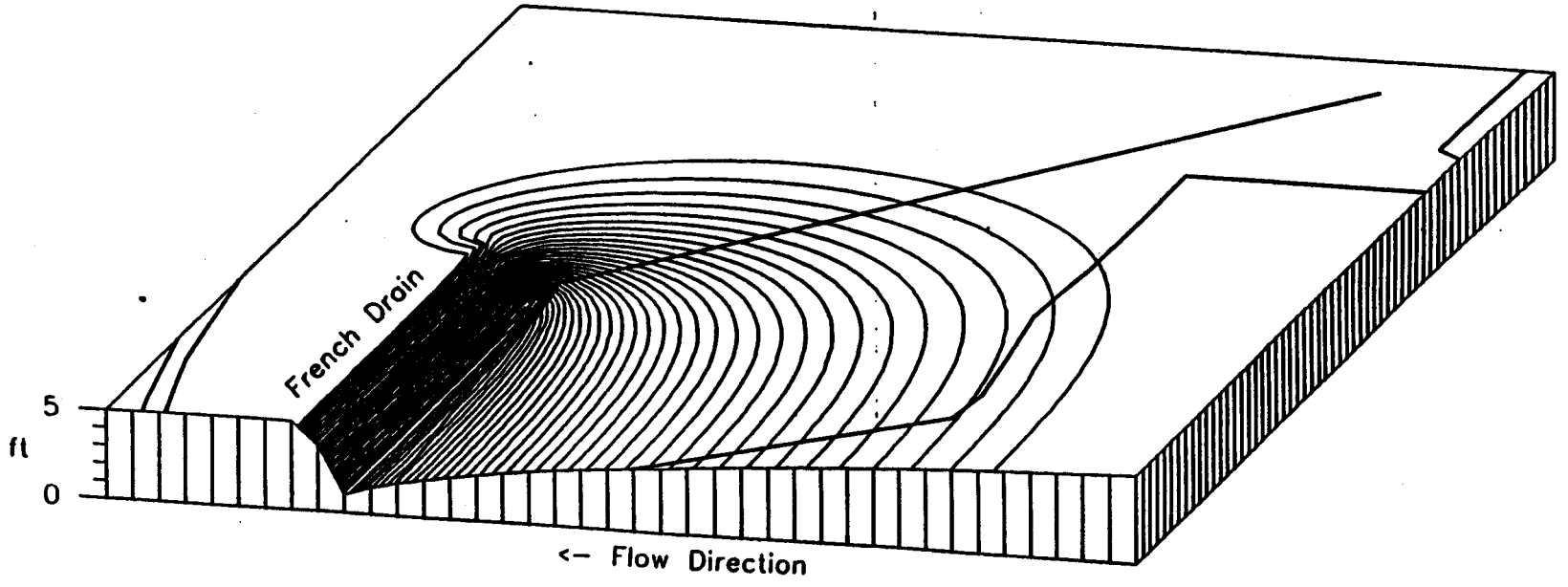
C.I. 0.1 ft

3/24/92

Modeled French Drain Drawdown at 3 Years



Modeled French Drain Water Table 3 Years



C.I. 0.1 ft

3/24/92

APPENDIX B

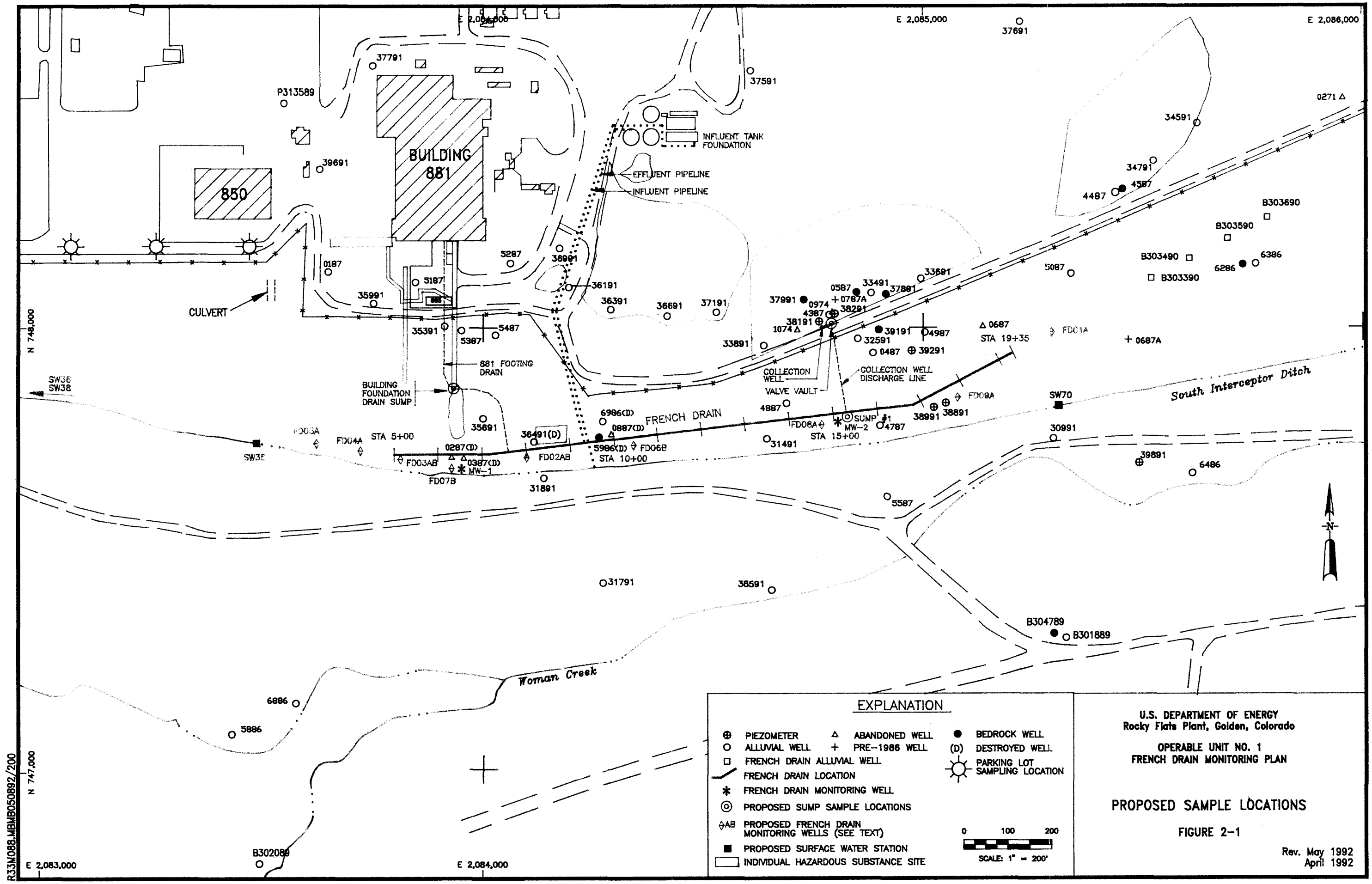
HYDRAULIC CONDUCTIVITY OF BEDROCK – BOTTOM OF TRENCH

APPENDIX B

Hydraulic Conductivity of Bedrock—Bottom of Trench

Test Station	Test Date	K (cm/s)
10+45	01/20/92	7.084 E-07
11+35	NA	3.6412 E-08
12+35	01/03/92	1.36 E-07
13+50	12/31/91	5.48 E-08
14+30	12/30/91	4.84 E-08
15+40	12/16/91	3.42 E-08
15+70	11/22/91	2.55 E-08
16+70	11/25/91	1.07 E-07
18+50	12/12/91	2.55 E-08
18+60	12/16/91	8.73 E-08
19+28	12/16/91	1.34 E-07

cm/s = centimeters per second
K = Hydraulic conductivity
NA = Not available


E 2,085,000
E 2,086,000
37691
37791
37591
P313589
39691
BUILDING 881
850
INFLUENT TANK FOUNDATION
EFFLUENT PIPELINE
INFLUENT PIPELINE
0271 Δ
34591
34791
4587
4487
B303690
B303590
B303490
6386
6286
B303390
5087
0187
5287
36991
5187
36191
35991
36391
36691
37191
CULVERT
N 748,000
35391
5387
5487
33891
37991
0587
33491
37881
33691
0974
0787A
4387
38291
38191
1074 Δ
39191
4987
32591
0487
39291
Δ 0687
STA 19+35
FD01A
0687A
861 FOOTING DRAIN
COLLECTION WELL
COLLECTION WELL DISCHARGE LINE
VALVE VAULT
BUILDING FOUNDATION DRAIN SUMP
SW36
SW38
35691
6986(D)
0887(D)
FRENCH DRAIN
4887
FD08A
SUMP #1
MW-2
4787
38991
38891
SW70
South Interceptor Ditch
30991
FD05A
FD04A
STA 5+00
SW35
0287(D)
36491(D)
FD03AB
0387(D)
MW-1
FD02AB
5986(D)
FD06B
STA 10+00
31491
STA 15+00
39891
6486
FD07B
31891
5587
31791
38591
B304789
B301889
Woman Creek
6886
5886
N 747,000
B302089
E 2,083,000
E 2,084,000
N
EXPLANATION
PIEZOMETER
ALLUVIAL WELL
FRENCH DRAIN ALLUVIAL WELL
FRENCH DRAIN LOCATION
FRENCH DRAIN MONITORING WELL
PROPOSED SUMP SAMPLE LOCATIONS
PROPOSED FRENCH DRAIN MONITORING WELLS (SEE TEXT)
PROPOSED SURFACE WATER STATION
INDIVIDUAL HAZARDOUS SUBSTANCE SITE
ABANDONED WELL
PRE-1986 WELL
BEDROCK WELL
(D) DESTROYED WELL
PARKING LOT SAMPLING LOCATION
0 100 200
SCALE: 1" = 200'
U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant, Golden, Colorado
OPERABLE UNIT NO. 1
FRENCH DRAIN MONITORING PLAN
PROPOSED SAMPLE LOCATIONS
FIGURE 2-1
Rev. May 1992
April 1992
R33W088.MBMB050892/200

LEGEND

- BUILDING OR STRUCTURE
- PAVED AREA
- FENCE
- RAILROAD TRACK
- UNDERGROUND STRUCTURE

BUILDING 850

CONCRETE–LINED RUNOFF DISCHARGE CHANNELS

CULVERT

GRAPHIC SCALE

U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant, Golden, Colorado

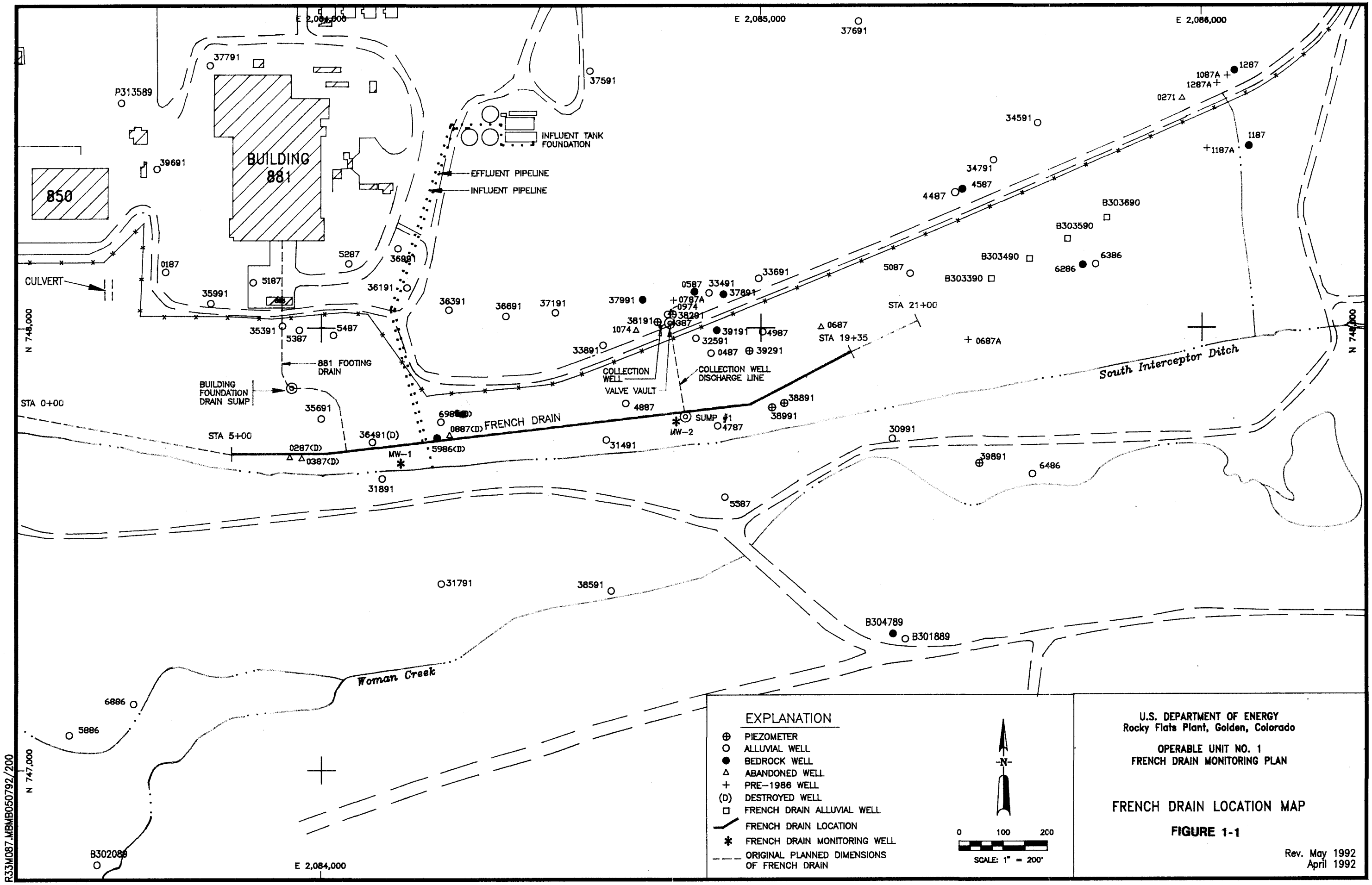
OPERABLE UNIT NO. 1
FRENCH DRAIN MONITORING PLAN

ROCKY FLATS PLANT

FIGURE 1–4

Rev. May 1992
April 1992

R33M090.MB050192/200



U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant, Golden, Colorado

OPERABLE UNIT NO. 1
FRENCH DRAIN MONITORING PLAN

FRENCH DRAIN LOCATION MAP

FIGURE 1-1

Rev. May 1992
April 1992

R33M087.MBMB050792/200